

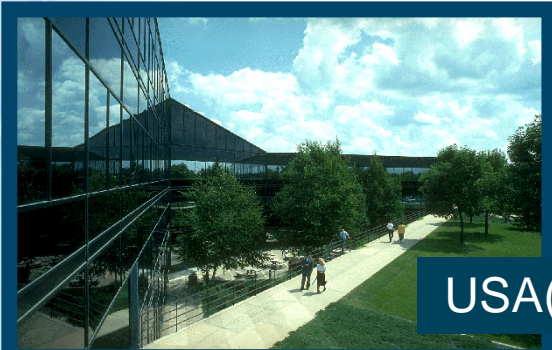
# **Diesel Emission Reduction Technologies**

*WI DNR – Rule 411 Rules discussion*  
**October 5, 2006**

# Agenda

- Retrofit technology
- Retrofit experience
- Resolve concerns about retrofits

# Donaldson Company, Inc.



USA(MN)

Key Sales &  
Technical  
Center  
Locations



Belgium



Singapore

- 90 yr history
- \$1.8 billion annual sales
- 11,000+ employees
- 38 manufacturing facilities in 19 countries

# Diverse Filtration and Exhaust Experience

## Engine Applications

### Off-road Equipment



### On-road Trucks and Buses



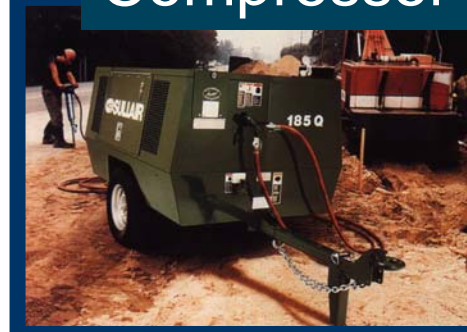
### Light Vehicle



### Defense



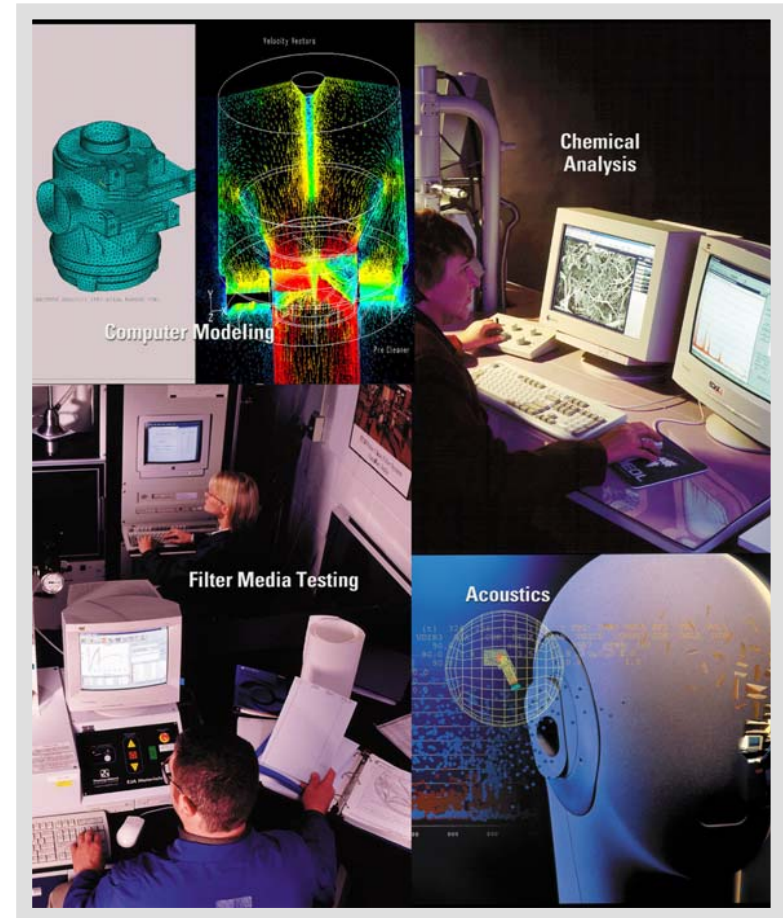
### Compressor Products





# Emission Control Experience

- More than 700,000 Diesel Oxidation Catalysts sold since 1993
- On-road truck and bus applications



# Diesel Emissions

- Hydrocarbons - HC (diesel odor)
- Carbon Monoxide - CO
- Particulate Matter – PM (soot)
- Oxides of Nitrogen - NO<sub>x</sub>
- Regulations focus on PM and NO<sub>x</sub>
  - Health & toxicity concerns
  - Both contribute to smog formation

# Benefits of 2007 Regulations

- According to the EPA, by 2030 they will prevent
  - 8,300 premature deaths
  - 9,500 hospital visits
  - 1.5 million lost workdays
  - 360,000 asthma attacks

# Retrofit Applications

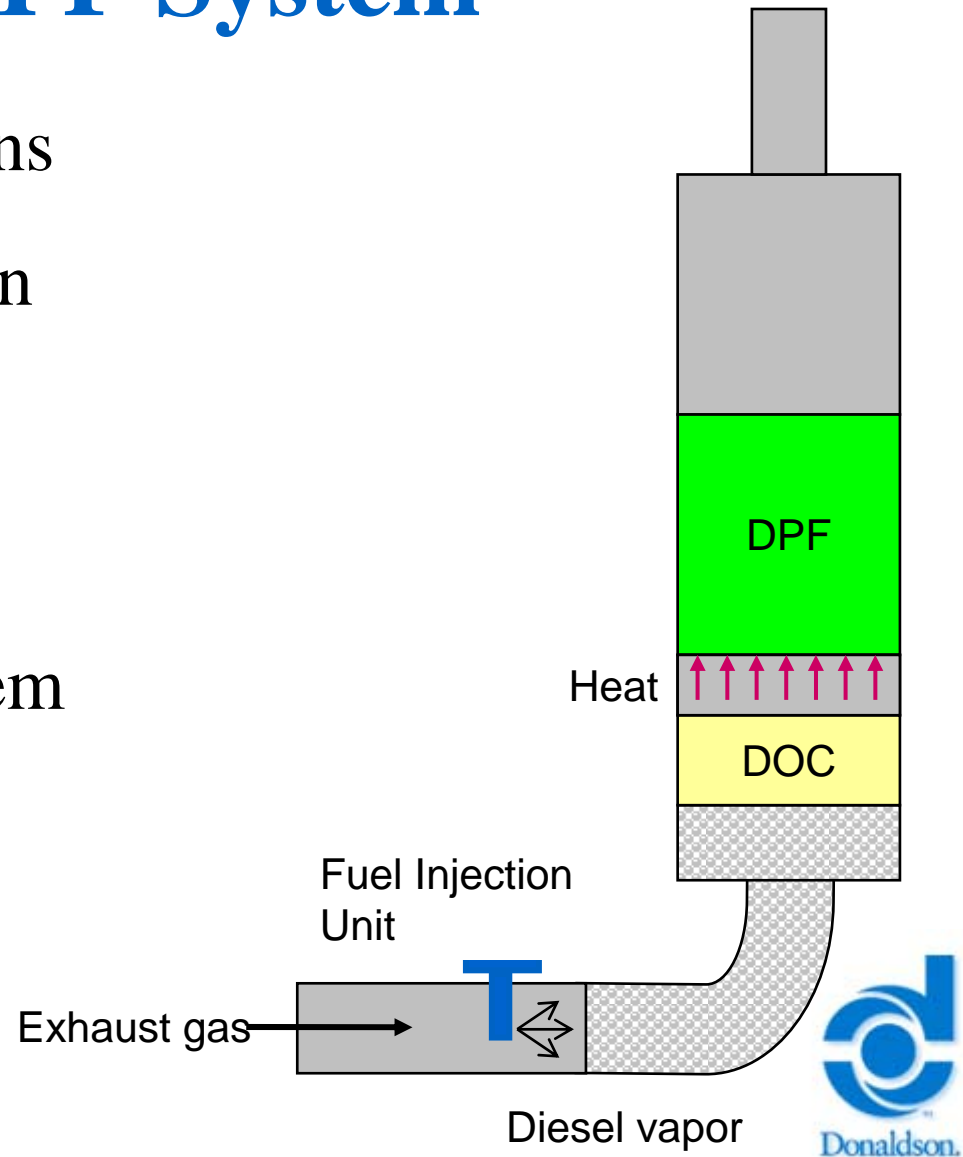
- Urban Buses
- School Buses
- Refuse Vehicles
- Municipal Vehicles
- Off-road Equipment





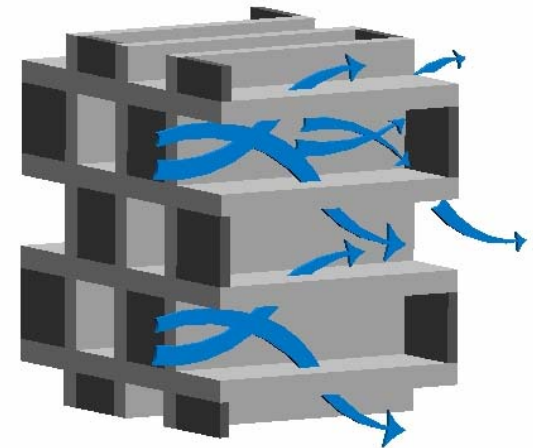
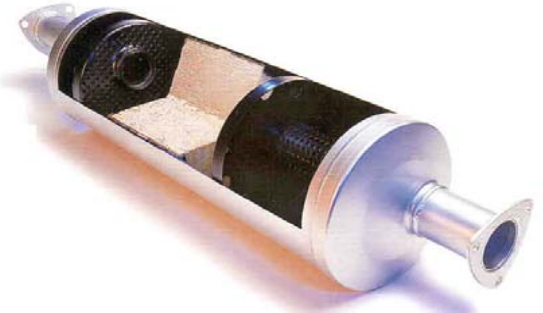
# EPA07 Compliant Active DPF System

- On-road applications
- 85+% PM reduction
- Requires ULSD
- EPA 2007 solution
- Fuel injection system



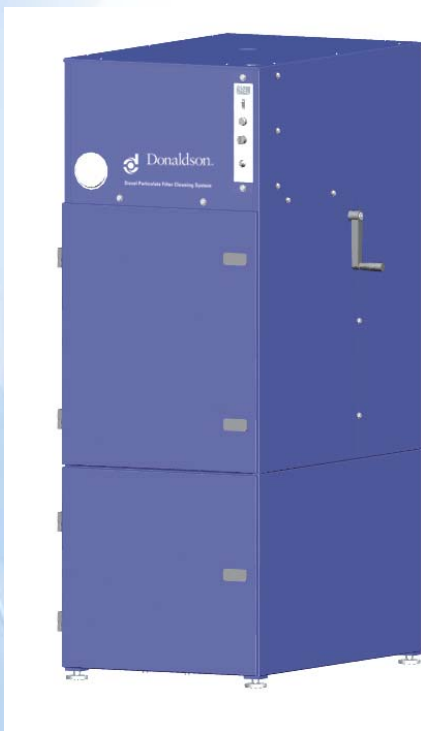
# Diesel Particulate Filter (DPF)

- Wall through technology
- 85+% PM reduction
- Exhaust-temperature sensitive → Data-logging required to determine suitability
- Requires ULSD
- Periodic cleaning
- \$7000-8000 installed
- 3 hr installation



# DPF Cleaning Maintenance

## Two-Stage DPF Cleaner System



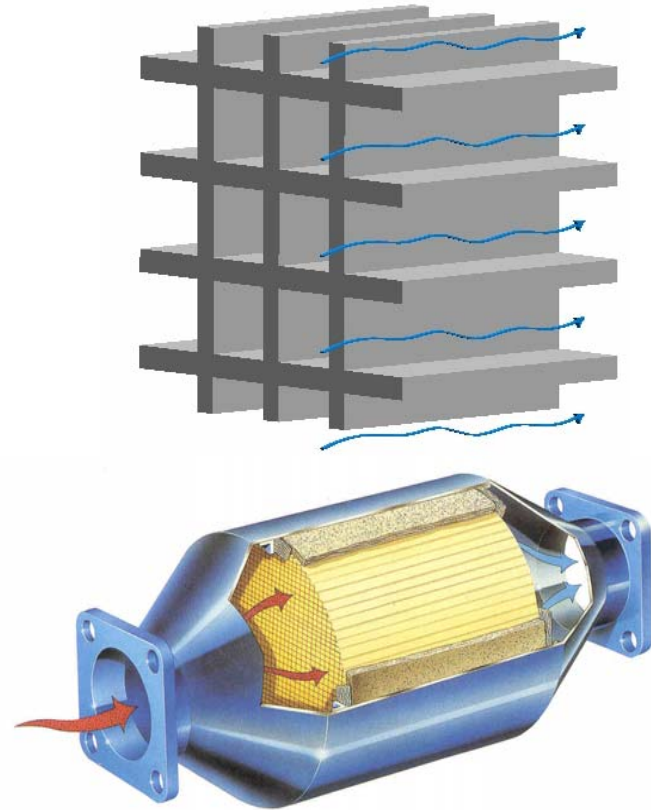
1<sup>st</sup> Stage  
Pulse Cleaner



2<sup>nd</sup> Stage  
Thermal  
Regenerator  
6 hour cleaning cycle

# Diesel Oxidation Catalysts (DOC)

- Flow through technology
- About 20% PM reduction
- Very reliable
- Operates with any fuel
- Maintenance free
- \$1200-2500 installed
- 1-2 hr installation
- 5 yr/100K mile warranty (on-road)



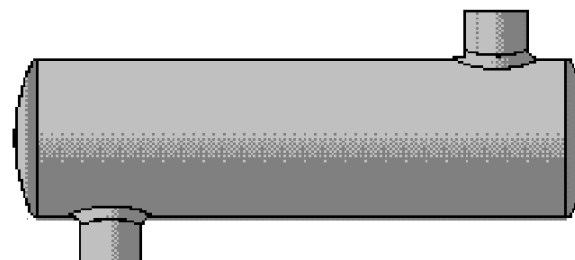
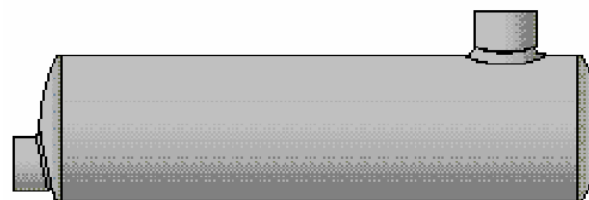
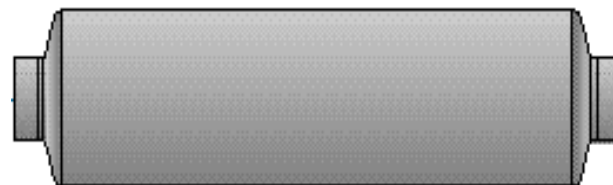


# Off-Road Retrofit

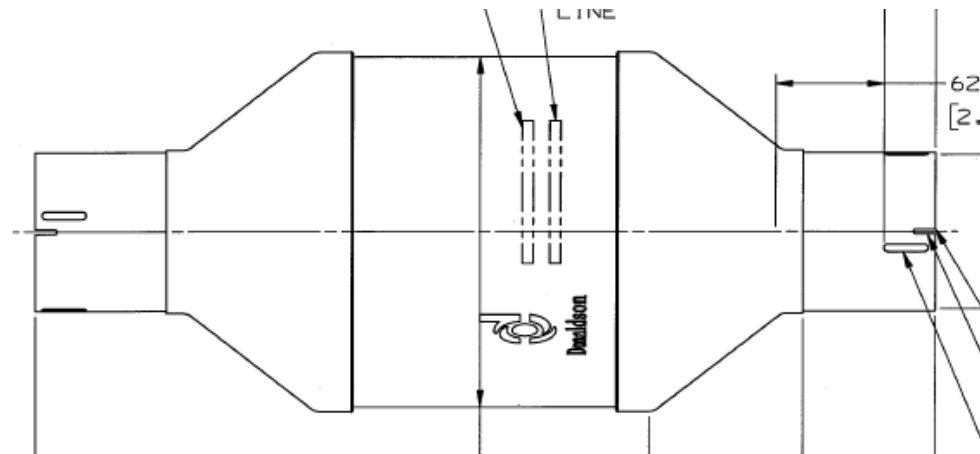
- Higher flows and HP
  - Dual systems, i.e. 2-20"dia
- Limited space for installation
  - May not fit under hood
  - On hood, on cab
- Lower backpressure limits – 2 vs. 3"Hg
- Scavenge systems increase backpressure

# Typical Off-Road Configurations

- Muffler Styles
  - Round Sizes
    - 3” through 14” diameter
  - Oval Sizes
    - 3” x 6.5” through 16” x 24”
  - Inlet / Outlet Tube Sizes
    - 1” through 10” diameter



# Independent Catalytic Converter (ICC)



# Donaldson Off-Road Experience

- Front End Loaders
  - New York City
- Yard hustlers, RT Gentries, Top picks, Side picks, Lift trucks
  - Ports of LA, Long Beach, Oakland
- Irrigation pumps, Front-end loaders
  - California



# DOC on Loader



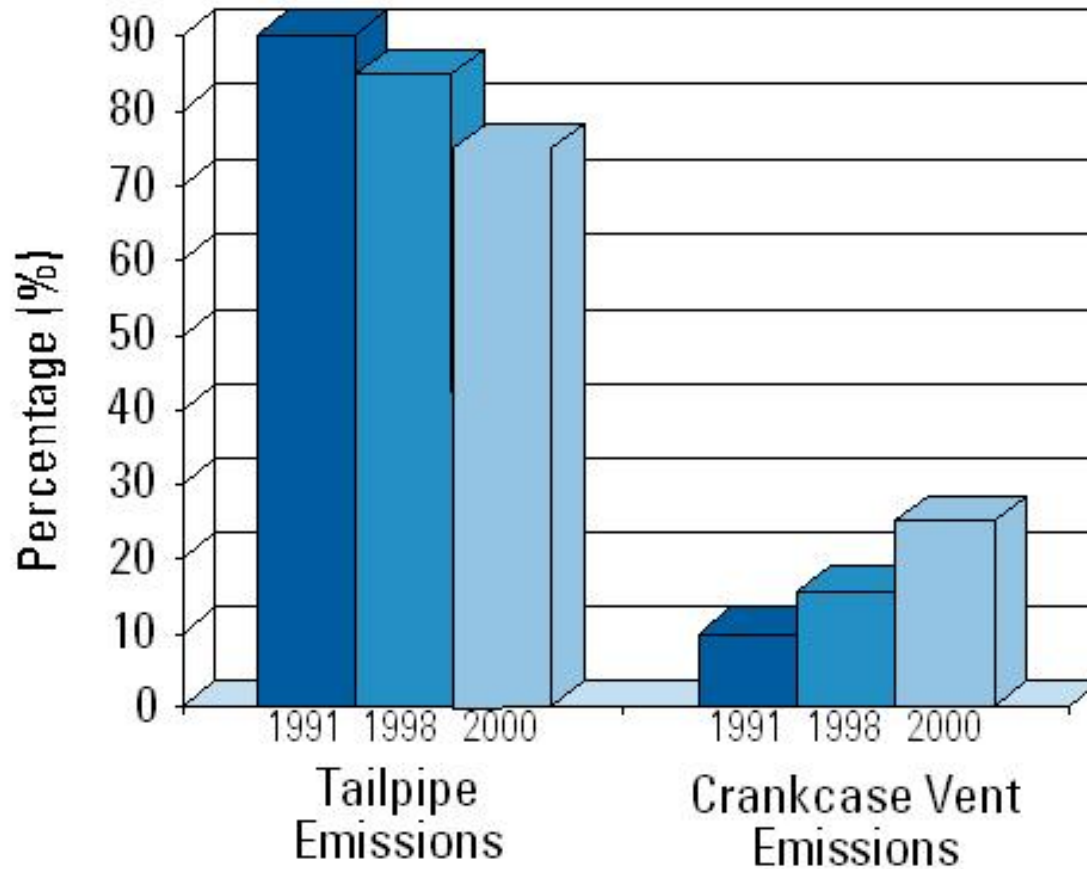




# Total Emissions Approach

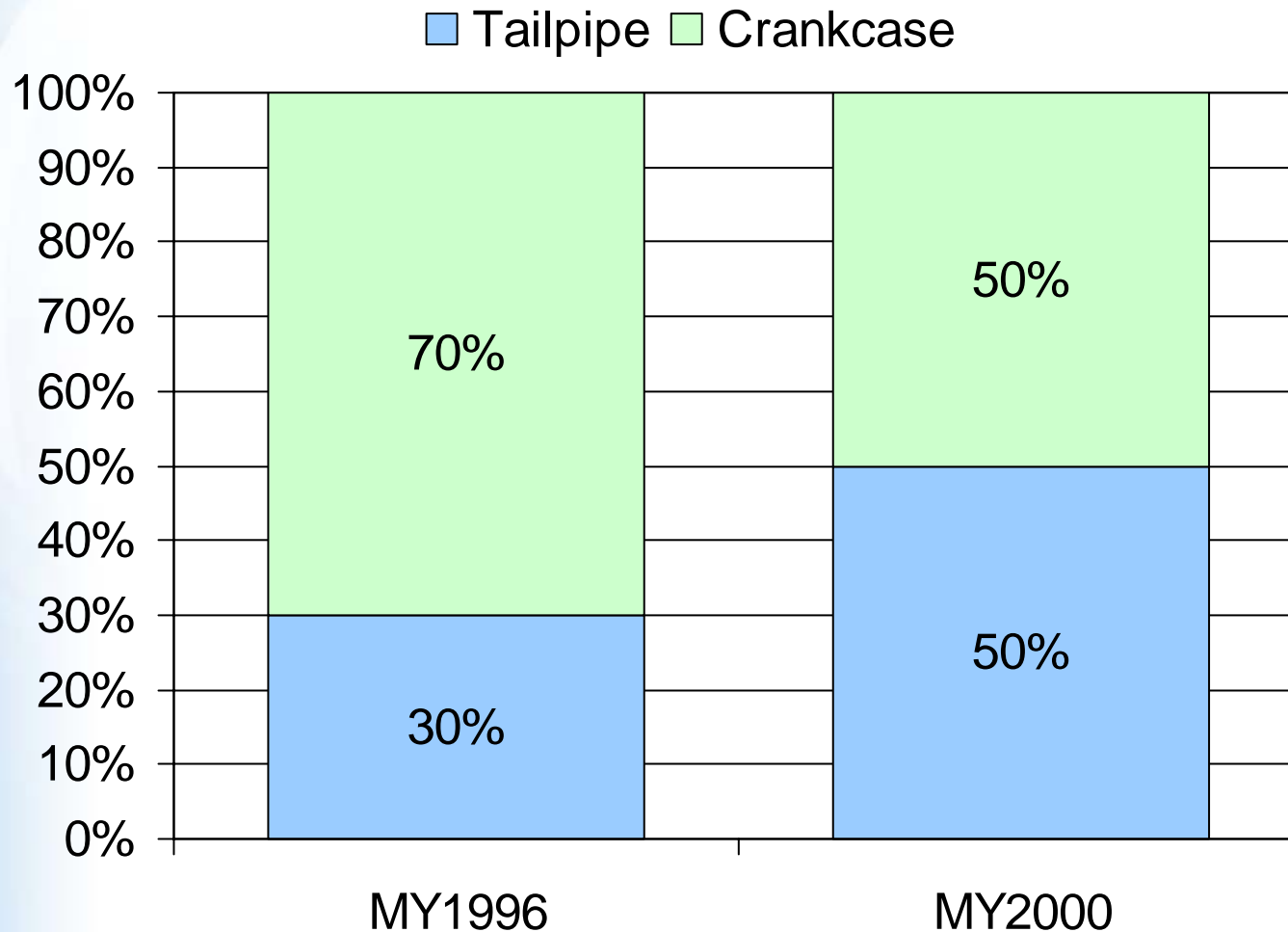
- Diesel engines have two emissions sources - tailpipe and crankcase vents
- Open crankcases emit blow-by emissions into the environment
- Crankcase emissions account for a significant amount of particulate matter

# PM During Load



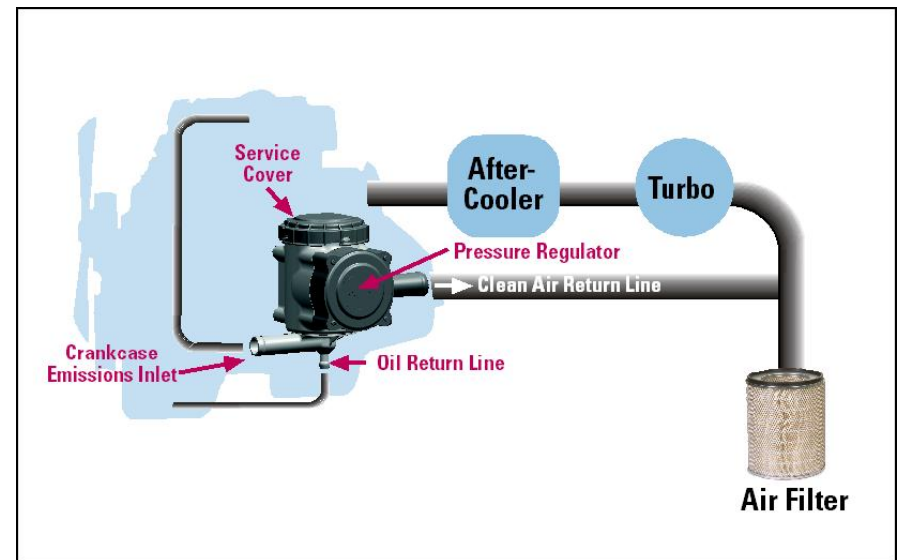


# PM at Idle



# Closed Crankcase Ventilation Filter

- Eliminates emissions from crankcase
- Two stage filter protects engine
- Filter change required every 500 hr
- 2.5-3.0 hr installation



# Spiracle on Loader



05.08.2003

# Summary

- DOCs
  - Proven technology
  - Fuel flexible
  - Maintenance free
  - Low cost
  - Easy to install



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